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Visualising Geomorphology: Improving Communication Of Data and Concepts Through Engagement With the Arts

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Previous ESEX commentaries have raised concerns over the limited, possibly even decreasing, visibility of geomorphology as a discipline and a term (e.g. Tooth, 2009; Gregory et al., 2014; Woodward, 2015). Proposed solutions have focused on ways to improve communication of geomorphology, but have tended to emphasise traditional forms of academic dissemination, including meetings (Gregory et al., 2014) and textbooks (Woodward, 2015). The contention of this commentary is that greater engagement with the arts can provide alternative communication channels for our data and concepts, and thereby help to raise the visibility of geomorphology, both literally and metaphorically.

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Context

Recent years have seen increased collaboration between the arts and sciences, with conferences, exhibitions and residencies devoted to exploring the inspirations and mutual benefits that can arise from activities that bridge the two spheres. Critical commentaries have focused on the tensions between art's roles in illustrating, communicating, and interrogating sciences such as biology, chemistry, physics, climate change and geology (e.g. Kemp, 2000; Ede, 2005; Wilson, 2010; Miller, 2014; Gorman, 2014). But where is geomorphology? The discipline has a rich visual subject matter that has long offered aesthetic inspiration for artists (e.g. painters, photographers, sculptors, poets, film makers, musicians), and there are historical examples where geomorphologists have engaged with the arts to help communicate data and concepts, including by embedding artists in scientific expeditions (Rees, 1973). Presently, however, geomorphology-art collaborations remain limited in number and scope, and so the potential intellectual benefits and opportunities for promoting geomorphology as an active, relevant science remain underexploited.

To address this issue, the British Society for Geomorphology's 'Visualising Geomorphology' Working Group has been established. The Group's remit is to explore the possibilities for engagement with the arts (broadly defined to include diverse visual and non-visual forms of creative expression) to help raise the visibility of the Society and the discipline more generally. To prompt discussion, the following sections address interrelated issues that include historical, contemporary and forward-looking aspects of geomorphology-art relations.

Geomorphology as artistic inspiration

Earth surface processes and landforms provide a kaleidoscope of perspectives, colours, textures, smells and sounds that can provoke aesthetic inspiration across the visual and non-visual arts. Resulting art works may be displayed (paintings, photographs), projected (films), performed (poetry, music) or installed (sculptures). Land art works, such as by Richard Long or Robert Smithson (Figure 1), are made directly in the landscape by sculpting earth or building structures using natural materials including boulders and organic debris (Tufnell, 2006). Yet despite geomorphological subject matter serving as inspiration, with the resulting art works helping to shape perceptions of landscape, these examples only serve to highlight that the geomorphological community has been slow to seize the opportunities for promoting the discipline. Does a landscape painting, photograph, poem or land art work – valuable though they may be in cultural terms – lead to enhanced awareness of the geomorphological discipline, or to greater appreciation of geomorphologists' roles in society? In most cases, the answer is likely 'no'. Many landscape-inspired artists share conceptual concerns with geomorphologists – for instance, in conveying the nature of time and history, process and material flux, and human influence – but their activities commonly remain largely divorced from geomorphological science. Even where artists have a background in geomorphology (e.g. photographer James Balog) and the subject matter is explicitly geomorphological (e.g. rapid changes to glacial landscapes), the discipline is rarely mentioned, or the subject matter is commonly badged with alternative (supra)disciplinary labels (e.g. 'geology', 'geoscience'). Where benefits have accrued to geomorphology from artistic works, these are usually incidental and after-the-fact; for example, some geomorphologists have mined historical paintings, poems or other documents to reconstruct past

environments, including flood and tsumani events, glacial and fluvial landscape dynamics, and changing societal perceptions of landscape (e.g. Zumbühl et al., 2008; Goff, 2012; Griffiths and Salisbury, 2013).

Figure 1 here

The artistic aspects of geomorphology

Artistic decisions are involved when representing complex three-dimensional landforms on a flat page, particularly when attempting to incorporate a sense of temporal change. Traditionally, visualisation in geomorphology has revolved around sketches, plan view maps, cross sections, use of block diagrams ('cartoons'), graphs, and photographs. As with all aspects of science imaging (Frankel, 2004), decisions need to be made regarding features to include and ignore, perspective, scale, symbology, colour schemes and/or shading. These decisions are partly scientific and partly artistic, as shown by a particularly rich tradition in cartography and landscape change illustrations (Figures 2A-B), some of which arguably form artworks in themselves, while others have inspired artists (Crozier and Priestley, 2011).

Figure 2 here

In an increasingly technology-driven, digital world, which visualisation techniques remain most useful for communicating geomorphology? Field sketches – a prominent feature of D. Dixon et al.'s (2013) commentary on the aesthetic aspects of geomorphology – have long fallen out of fashion and nowadays are rarely

undertaken as part of research projects, let alone incorporated in publications, but might still have value in outreach (see below). But can the artistic decisions embedded in these traditional geomorphological visualisations be augmented by newer techniques that incorporate automated data capture, digital processing, and graphic design? Cartography and mapping, for instance, have derived major benefits from technological developments (e.g. high-resolution imaging tools such as LiDAR) with some outputs again forming artworks in themselves (Figure 2C). Landform and landscape photography has also benefitted greatly from technological developments (e.g. remotely sensed imagery, time lapse techniques, Structure-from-Motion photogrammetry, digital enhancement). Visualisation of dynamic earth surface processes and microforms is more challenging, but benefits have arisen from technological developments (e.g. high-magnification SEM imaging or high-speed photography), and the resulting images also may have aesthetic appeal (Figure 2D).

In other scientific disciplines, the merger of new technologies and visualisation techniques sometimes has gone beyond mere communication, and even helped to alter the direction of scientific research. Cressey (2014) cites historical examples where visual representations of medical data helped changed the way science was conducted. During the early phase of space exploration, a photograph showing our planet rising above the Moon's horizon ('Earthrise') contributed to the growth of environmentalism and the now-familiar scientific conception of the Earth as a system. Today, new technologies are opening up new physical frontiers (e.g. the deep oceans, other planetary landscapes), so could novel visualisations of captured data result in similarly transformative images for geomorphology?

New artistic approaches to communicate geomorphology to non-specialists

Engagement with artistic approaches undoubtedly can help communicate geomorphology among specialist academic audiences, but significant impacts can also be made in outreach contexts. Commenting on his 25-year tracking of a spherical chunk of oak down the Afon Dwyryd, north Wales, sculptor David Nash noted that this serendipitous piece of art "became a stepping-stone into the drama of physical geography" (Peterson, 2008). Along with land art works that ultimately become part of the topography (Figure 1), such 'experiments' could be more widely exploited for geomorphology's benefit, particularly by helping to communicate key concepts such as time, process, and material flux to non-specialist audiences. Could newer, technology-driven artistic approaches also be employed to communicate geomorphology to these audiences? Geomorphological subject matter has yet to feature widely among a recent surge in digital artworks but many possibilities exist, including using: i) video animations to visualise landscape change scenarios (e.g. with sea level rise); ii) laser scanning and 3D printing, or other novel sculptural approaches, to reveal 'invisible' landform details (e.g. abraded river pothole interiors, subterranean insect colony structures); and iii) naturally-derived 'soundworks' to enhance perception of geomorphological processes (e.g. the sonics of bedload transport or aeolian saltation). Multisensorial approaches that enable immersion inside virtual realities (e.g. using The Oculus Rift system) also offer many possibilities for communicating geomorphology (see SeriousGeoGames website).

Practical applications include improved communication of geomorphology at popular natural attractions. Accurate and engaging geomorphological information for landforms and landscapes is commonly non-existent or poorly presented, even in national parks. But the above artistic approaches – perhaps disseminated using podcasts or apps – could help enliven and/or enhance the design and display of geomorphological information traditionally presented on signboards or dioramas, including to people with impairments. For example, greater use of non-visual (auditory or tactile) artistic approaches for illustration of processes and landforms could help to communicate geomorphology to those deprived of visual faculties. Haptic use of 3D printing has great potential here, and the power of the written word in describing landscape change using non-technical language is also important (e.g. Norman Nicholson's poem 'Beck' - Whalley, 2014).

Irrespective of social or educational background, the 'beauty' or 'experience' of landscape is something that appeals to many people (Goudie and Viles, 2010) but could improved geomorphological communication through engagement with the arts further help to heighten landscape appreciation? This is a vexed issue but requires consideration, especially for geoconservation and geoheritage promotion. Case studies show how geomorphology is integral to many aspects of culture (Gregory, 2006) and abundant opportunities exist to interweave geomorphology with art and other knowledge forms in novel, engaging ways to heighten landscape appreciation. Alongside the technology-driven approaches highlighted above, and linked with revitalised debate over the role and value of fieldwork in geomorphological research and education (Legleiter and Marston, 2013; Thornbush et al., 2014), field locations can enable experimentation with alternative means of communicating

geomorphology to non-specialists in accessible and affective ways. Field-based participatory art projects that are concerned with collective interactions in the process of creating an art work or event (e.g. a landscape 'walkover') offer particular opportunities. As part of these projects, landform sketching or poetic expression might help people to capture the personal essence of their landscape experience, while also providing opportunities to communicate geomorphology.

Possible ways forward?

Other scientific disciplines (e.g. biology, geology) have been proactively and successfully engaging with the arts to help communicate data and concepts, thereby raising their profiles. Geomorphology has been slow off the mark, so we end with some linked challenges: i) can we identify the types of geomorphological data and concepts that are best suited for visual and non-visual artistic expressions?; ii) how can we encourage more geomorphologists working with these types of data and concepts to consider engaging with the arts to communicate their research?; and iii) how can geomorphologists best cultivate mutually-beneficial collaborations with individuals from the arts communities?

Currently, some of the most fertile ground for engaging with the arts is provided by debates over future climate change and the putative Anthropocene. These topics are among the most forward looking parts of the geomorphological discipline and novel artistic approaches may be useful – indeed essential – for conveying the risks and uncertainties associated with imagined futures (cf. Sheppard, 2012). Many artists have latched onto the abundant imaginative possibilities offered by the Anthropocene debate, and are using novel combinations of photography, film,

sculpture and sound to communicate geomorphologically-relevant topics such as rapid landscape transformation, altered material fluxes, novel ecosystems, and the permanence or otherwise of human impacts (e.g. Davis and Turpin, 2015). We should tap into this creativity to help communicate geomorphology to fellow scientists and the wider public, and then feed into debates about options for landscape conservation, restoration and management in a rapidly changing world. Science is about communicating beautiful ideas (Cressey, 2014), whether through written language or other visual/non-visual forms. The challenge in geomorphology-art collaborations is to use approaches that communicate geomorphological meaning while maintaining artistic integrity.

References

Cotton CA. 1922. *The Geomorphology of New Zealand. Part 1: Systematic*. New Zealand Board of Science and Art Manual No. 3, Dominion Museum: Wellington.

Cressey D. 2014. Infographics: truth is beauty. *Nature* **507**: 304-305.

Crozier M, Priestley R. 2011. Charles Cotton: New Zealand's most influential geomorphologist. *New Zealand Geographer* **67**: 79-89.

Davis H, Turpin E, eds. 2015. *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies*. Open Humanities Press London.

Dixon DP, Hawkins H, Straughan ER. 2013. Wonder-full geomorphology: sublime aesthetics and the place of art. *Progress in Physical Geography* **37**: 227-247.

Ede S. 2005. *Art and Science*. I.B. Taurus and Co Ltd: London.

Fisk HN. 1944. *Geological Investigation of the Alluvial Valley of the Lower Mississippi River*. US Army Corps of Engineers.

Frankel F. 2004. *Envisioning Science: The Design and Craft of the Science Image*. MIT Press.

Goff J. 2012. Tsunamis and stranded vessels: up Ship Creek without a paddle? *Geographical Research* **50**: 102-107.

Gorman MJ. 2014. The third culture. *Nature* **510**: 216.

Goudie A, Viles H. 2010. *Landscapes and Geomorphology: A Very Short Introduction*. Oxford University Press: Oxford.

Gregory KJ. 2006. The human role in changing river channels. *Geomorphology* **79**: 172-191.

Gregory KJ, Lane SN, Lewin J, Ashworth PJ, Downs PW, Kirkby MJ, Viles HA. 2014. Communicating geomorphology: global challenges for the twenty-first century. *Earth Surface Processes and Landforms* **39**: 476–486.

Griffiths HM, Salisbury TE. 2013. 'The tears I shed were Noah's flood': medieval genre, floods and the fluvial landscape in the poetry of Guto'r Glyn. *Journal of Historical Geography* **40**: 94-104.

Kemp, M., 2000. *Visualizations: The Nature Book of Art and Science*. Oxford University Press.

Legleiter CJ, Marston RA. 2013. Introduction to the Special Issue: the field tradition in geomorphology. *Geomorphology* **200**: 1-8.

Miller AI. 2014. *Colliding Worlds: How Cutting-Edge Science is Redefining Contemporary Art*. WW Norton.

Peterson G. 2008. Slow ecological art. Available at: http://rs.resalliance.org/tag/art/page/2/ [Last access date: 30th April 2016].

Rees R. 1973. Geography and landscape painting: an introduction to a neglected field. *Scottish Geographical Magazine* **89**: 147-157.

SeriousGeoGames (no date). *SeriousGeoGames: Gamification for Earth Sciences*. Available at: https://seriousgeogames.wordpress.com/about/ [Last access date: 26th February 2016].

Sheppard SRJ. 2012. *Visualizing Climate Change: A Guide to Visual Communication of Climate Change and Developing Local Solutions*. Routledge.

Thornbush MJ, Allen CD, Fitzpatrick FA, eds. 2014. *Geomorphological Fieldwork*. Developments in Earth Surface Processes, Vol. 18, Elsevier.

Tooth S. 2009. Invisible geomorphology? *Earth Surface Processes and Landforms* **34**: 752–754.

Tufnell B. 2006. *Land Art*. Tate Publishing.

Whalley WB. 2014. On Beck. In: Matthews S, Curry N. eds. *Norman Nicholson at 100: Essays and Memoirs*. Bookcase, Carlisle.

Wilson S. 2010. *Art + Science Now*. Thames and Hudson.

Woodward J. 2015. Is geomorphology sleepwalking into oblivion? *Earth Surface Processes and Landforms* **40**: 706–709.

Zumbühl HJ, Steiner D, Nussbaumer, SU. 2008. 19th century glacier representations and fluctuations in the central and western European Alps: an interdisciplinary approach. *Global and Planetary Change* **60**: 42–57.

Figure 1 'Spiral Jetty' by Robert Smithson, constructed 1970 on the northeastern shore of the Great Salt Lake near Rozel Point, Utah, USA (photograph by Gianfranco Gorgoni, c.2003). As lake water levels fall and rise, the jetty is alternatively exposed and submerged. Originally consisting of black basalt against ruddy water, the earthwork is now more white against pink owing to salt encrustation. These and other 'living sculptures' ultimately become part of the topography, and represent a unique class of anthropogenic landforms.

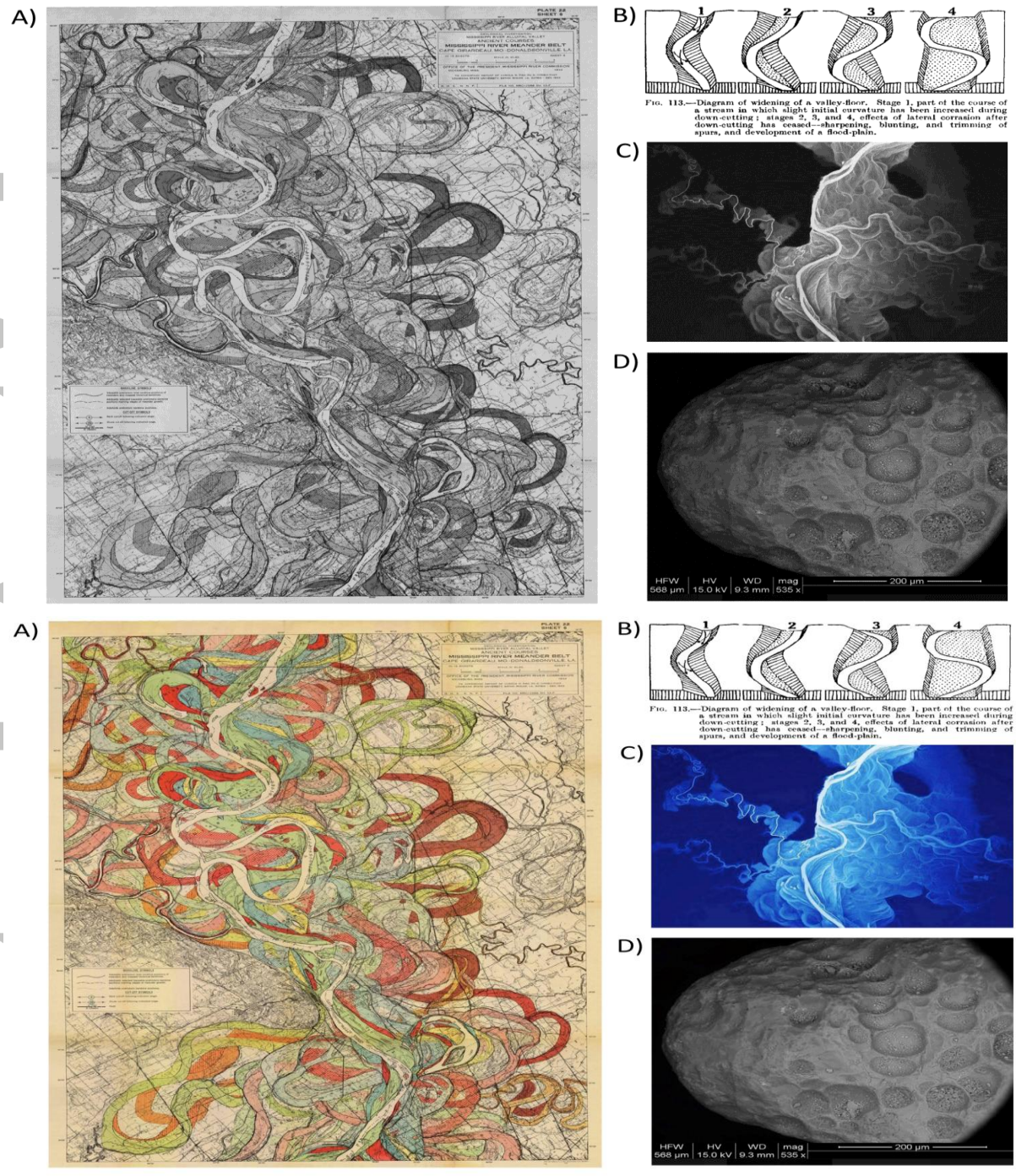

Figure 2 Examples of geomorphological images that also have aesthetic appeal, with A) to C) focusing on representations of river meanders:
A) one of the numerous maps produced by Harold Fisk to show the historical traces of the lower Mississippi River, USA (see associated report by Fisk, 1944);
B) one of the many illustrations produced by Charles Cotton, a New Zealand geomorphologist, to show a sequence of landscape development (Cotton, 1922). Cotton's simple, evocative illustrations provided inspiration for the landscape paintings of New Zealand artists Colin McMahon and Bob Kerr;
C) part of a colour-coded LiDAR image revealing the alluvial landforms of the Willamette River valley, Oregon, USA ('Willamette River Historical Stream Channels'

by Daniel E. Coe, courtesy of Oregon Department of Geology and Mineral Industries);
D) SEM image of a wind-blown basalt sand grain from Hawaii (R.A. Craddock, unpublished). Extensive pitting on the grain surface is made visible, revealing an otherwise hidden micro landscape.